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Incense-cedar

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LIBOCEDRUS

(incense-cedars)

This genus has 10 to 13, or fewer, species bordering the Pacific Ocean in North and South America, New Zealand, New Caledonia, New Guinea, mainland China, and Taiwan. One species is native in the United States.

The trees have thick, fibrous, light brown or reddish brown bark, which becomes deeply furrowed. The twigs are flattened in horizontal plane, much branched, and shed with the persistent leaves usually the second or third year.

The small scalelike, yellow-green leaves are paired or opposite in 4 ranks, much flattened, short-pointed, and extend down the twig at base.

A tree bears male and ovulate strobili singly at the ends of different twigs. The small oblong cones mature in one season but remain attached until the next year. They are composed of 6 paired, hard, flattened scales. Each of the 2 middle scales bears 2 seeds with 2 unequal wings. Cotyledons 2.



INCENSE-CEDAR (*Libocedrus decurrens* Torr.)

Other common name: California incense-cedar.

Incense-cedar is one of the most distinctive trees in the mixed-conifer stands of Western United States. Its range extends from the southern slope of Mt. Hood in Oregon southward through the Cascade, Siskiyou, Coast Range, and Sierra Nevada Mountains to the Sierra de San Pedro Martir in Lower California.

HABITAT CONDITIONS

Climate

The climate in which incense-cedar grows is characterized by dry summers, usually less than 1 inch of precipitation per month during the summer months; annual temperature extremes of about -30° F. and 110° ; and usually 20 to 80 inches annual precipitation, part of which falls as snow. Precipitation may be as low as about 15 inches a year for incense-cedar found on the east side of the Cascades and in the Warner Mountains in Oregon and California.

Soils and Topography

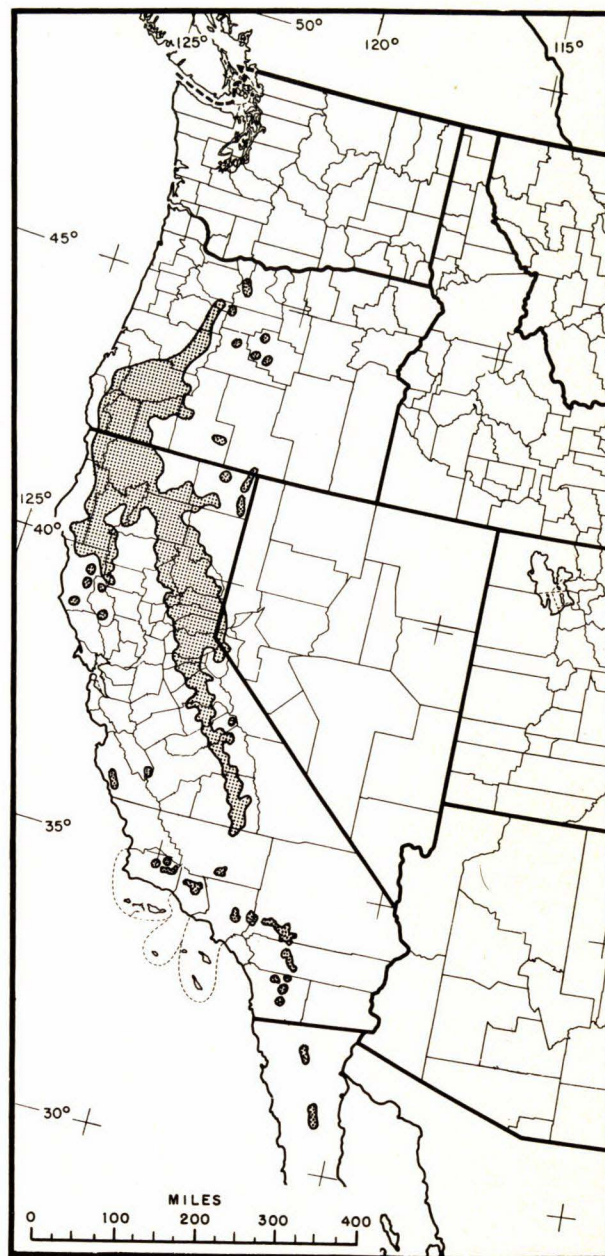
Incense-cedar grows on many kinds of soils developed from weathering of a wide variety of parent rocks—rhyolite, andesite, diorite, sandstone, shale, basalt, serpentine, and granitic or metamorphic equivalents.

Soils of the western and eastern slopes of the Cascades and in the Siskiyou Mountains in Oregon are quite variable (19).¹ The acidity varies from nearly neutral to strongly acid. Textures range from very coarse soils to very fine clays. The best stands are generally found on deep, well-drained, sandy loam soils developed on granitic rocks and sandstone; deep clay loams developed on basalt and rhyolite; and deep, coarse-textured, well-drained soils developed from pumice.

In California, incense-cedar grows best on deep, slightly to moderately acid, sandy loam soils of the Holland series, developed from granitic rocks, and the Olympic series, derived from basalt and andesite. These soils are common in the central Sierra Nevada.

Incense-cedar is also found in isolated spots in the Coast Ranges growing on soils developed from serpentine. Though it grows better than other conifers on these soils, its growth is considerably less than on the other soil types.

Incense-cedar is more common on west-facing



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The range of incense-cedar.

than on east-facing mountain slopes. It grows at increasingly higher elevations toward the southern part of its range and on the east slopes. In the Cascades it generally occurs at 2,000 to 5,000

¹ Italic numbers in parentheses refer to Literature Cited, p. 247.

feet on the west side and 5,000 to 6,600 feet on the east side. In the Coast Ranges it grows between 1,200 to 6,000 feet. In the central Sierra Nevada, where the best stands occur, it is found between 2,000 and 7,000 feet. On San Jacinto Mountain in southern California, it occurs at 3,000 to 8,000 feet; and in the Sierra de San Pedro Martir, above 7,500 feet.

Associated Trees and Shrubs

Incense-cedar seldom grows in pure stands except over very small areas. Under the more favorable conditions for its development, it may form up to 50 percent of the stand (20); however, it usually comprises less than 30 percent of the stand on a stem basis.

Incense-cedar is rarely a major component of any of the six forest cover types of western North America in which it occurs. It is most abundant in the Ponderosa Pine—Sugar Pine—Fir Type (Type 243) (referred to by some as the mixed-conifer type) and a minor component in the following cover types: Pacific Douglas-Fir (Type 229), Pacific Ponderosa Pine—Douglas-Fir (Type 244), Pacific Ponderosa Pine (Type 245), California Black Oak (Type 246), and Jeffrey Pine (Type 247).

In the northern part of its range it is commonly associated with Douglas-fir, ponderosa pine, sugar pine, western white pine, white fir, grand fir, western hemlock, western redcedar, Port-Orford-cedar, California black oak, tanoak, golden chinkapin, and Pacific madrone.

In the central part, it associates with ponderosa pine, sugar pine, Jeffrey pine, lodgepole pine, white fir, California red fir, giant sequoia, California black oak, tanoak, golden chinkapin, and Pacific madrone.

In the southern part, common associates are Jeffrey pine, ponderosa pine, sugar pine, Coulter pine, and bigcone Douglas-fir.

Common brush species growing with incense-cedar are greenleaf manzanita (*Arctostaphylos patula*), mountain whitethorn (*Ceanothus cordulatus*), deerbrush (*C. integerrimus*), snowbrush (*C. velutinus*), littleleaf ceanothus (*C. parvifolius*), bearmat (*Chamaebatia foliolosa*), bush chinkapin (*Castanopsis sempervirens*), salal (*Gaultheria shallon*), and coast rhododendron (*Rhododendron californicum*).

LIFE HISTORY

Reproduction and Early Growth

Flowering and fruiting.—The pollen-bearing strobili are about $\frac{1}{4}$ inch long in early spring at the time of pollen shedding. The conelets are

usually small and not noticeable until later. By late summer the pendant cones are from $\frac{3}{4}$ to $1\frac{1}{2}$ inches long. The cones—consisting of two seed-bearing scales with two seeds each—mature in one season and shed their seeds during late summer and fall.

Seed production and dissemination.—Incense-cedars are prolific seed bearers; however, they do not produce seeds every year (11). During a 28-year period, incense-cedar on the Stanislaus National Forest (Tuolumne County, Calif.) had 6 cone crops rated as heavy or very heavy, 8 medium-size crops, and 14 rated as none or light. During this period the interval between medium or heavier cone crops varied from 3 to 6 years.

The best seed year in this study was 1934 when seed traps indicated a seedfall of 186,210 seeds per acre (11). The highest on an individual plot was 389,100 seeds per acre.

During the study, 14 to 65 percent of the seed in the seed trap collections were sound (11). The highest number of sound seed occurred during heavy seed years; the lowest during light seed years.

Little information is available on the seed production of individual trees. The relationship between seed production and stand volume in immature and mature dominants indicates that relatively small volumes in cutover stands—as little as 500 board feet—will produce approximately 100,000 seeds per acre (11). Full-crowned dominant trees in the immature age class have been observed to bear tremendous quantities of cones.

Destruction of seed is not particularly serious in incense-cedar. Some losses are caused by sawflies (*Augomonoctenus libocedri*) which attack the cones (15). Squirrels, particularly the Douglas squirrel, at times cut down incense-cedar cones; however, they usually destroy only a few cones (11). But during poor seed years of pines, firs, or brush, rodents eat greater quantities of incense-cedar seeds.

Seed dissemination begins in late August at the lowest elevations and in October at the higher levels. Some seeds may fall during the winter months. The percentage of the total seed crop that fell at different observation dates on the Stanislaus National Forest at 6,000 feet elevation was (11):

Year and date	Seed caught in seed traps—	
	All seed (percent)	Sound seed (percent)
1937:		
Oct. 6.....	11	3
Oct. 27.....	36	37
Nov. 11.....	53	60
1940:		
Oct. 11.....	32	54
Oct. 29.....	34	38
Nov. 13.....	34	8

Incense-cedar seeds average 15,000 per pound

and range from 6,400 to 29,000 per pound. The seeds have a relatively large wing for their weight and are carried great distances by air currents. In still air, the seeds fall at the rate of 5.9 feet per second (18).

Seedling development.—Germination of seed in the field usually varies from 20 to 40 percent (10, 16). In the first stages, seedlings often develop best under partial shade. On exposed sites where soil moisture is rapidly depleted through evaporation, the seedlings seldom extend their roots fast enough before the dry season sets in. During a period of 18 to 24 years after logging, 10,092 seedlings per acre started on a series of cutover plots on the Stanislaus National Forest (9); 84 percent were incense-cedar. Of the 2,749 seedling alive at the end of the period, 78 percent were incense-cedar. The incidence of incense-cedar seedlings by ground surface conditions on these plots was:

Ground surface condition	Seedling incidence (percent)
Bare ground.....	1
Brush	51
Litter	41
Logs, rocks, and other debris	7

Seedling mortality is frequently high. Cutworms and drought destroy many seedlings; rodents are generally of only minor importance. During a 5-year period, 53 percent of the 1- to 2-month-old incense-cedar seedlings on the Stanislaus plots were destroyed by cutworms (*Noctuidae* larvae) (7). The seed to seedling ratio on 4 cutover plots varied from 20:1 to 355:1 (11). Drought may kill many incense-cedar seedlings during the first growing season, but these losses are usually less than those caused by insects (7). Losses from low soil moisture are most noticeable on dry sites and on compacted landings and skid roads.

First-year development of incense-cedar seedlings is usually slower than that of the associated pines. The primary root extends to a depth of about 12 inches during the first growing season—about one-half to two-thirds the length of ponderosa or sugar pine of the same age. Lateral roots begin development early in the first season and continue at a greater rate than the taproot. Incense-cedar seedlings may take 3 to 5 years to grow the first 6 inches in height; pines the same age are normally 2 to 3 times as tall. After the fifth year the rate of height growth increases, but at no time does it approach that of its associates.

Seasonal height growth of incense-cedar on the Stanislaus Experimental Forest starts earlier than for sugar pine and white fir, but later than for ponderosa or Jeffrey pine (8). The average date growth started at an elevation of 5,200 feet was May 24. Growth was completed in an average of 91 days—a longer period than for any of the associated species.

Seasonal radial growth starts before height growth. At the Stanislaus Experimental Forest radial growth began about April 15. This was about the same as ponderosa pine, but earlier than sugar pine and white fir. The average period of radial growth was 136 days. Half of the total radial growth was completed in 39 days (8).

Incense-cedar does not reproduce naturally by sprouting or rooting.

Sapling Stage to Maturity

Growth and yield.—In the coast ranges and in southern California the largest trees are generally from 60 to 80 feet high and 3 to 4 feet in diameter. In the Sierra Nevada, incense-cedars frequently grow 150 feet tall with diameters up to 7 feet. The largest tree was about 11.5 feet in diameter (1). A tree 225 feet tall was recently reported in southern Oregon. At high elevations, especially on dry exposed sites, the trees tend to be small and scrubby.

Incense-cedar is long-lived; large trees are often



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A large incense-cedar on the Lassen National Forest, Calif.

more than 500 years old (16). The oldest recorded age was 542 years for a tree only 51 inches d.b.h.; larger trees may be older. It has an extensive, well-developed lateral root system and, therefore, is quite wind-firm.

Incense-cedar ordinarily makes its most rapid height growth between 50 and 75 years old (16). On good sites—A-200 and I-175 (5)—height growth continues to be rapid up to 150 years. Beyond 150 years, height growth is very slow.

Basal area growth of incense-cedar is usually slower than that of the associated species (4, 17). On medium or poorer sites the growth rate is lower than that of white fir, Douglas-fir, sugar pine, or ponderosa pine. However, on some poor sites, the basal area growth of incense-cedars up to about 24 inches in diameter may exceed all other species except white fir (4).

On the Stanislaus Experimental Forest the average gross volume of a cutover area of 200 acres was 79,100 board feet per acre, of which 13.4 percent was incense-cedar. Although mixed stands may contain many incense-cedar, particularly in the younger age classes, the trees rarely make up more than 5 to 10 percent of the stand volume (6).

Reaction to competition.—Incense-cedar is usually rated as tolerant (2). It is more shade tolerant than the associated pines and Douglas-fir, and less tolerant than white fir and grand fir. In the seedling stage incense-cedar can endure dense shade, but for full development from sapling stage through maturity it requires more light (16).

Incense-cedar shows good response to release. Much of the extremely slow growth of young reproduction is caused by suppression. When released, these seedlings make rapid height growth. However, height growth is slower than that of the associated species of comparable age, and incense-cedar will always be a secondary species in the final stand (4). Incense-cedar does not readily shed its lower branches even in dense stands. Many dead branches must be removed if high quality clear lumber is to be produced in rotations of 80 to 120 years.

Principal enemies.—Incense-cedar is noted for the durability of its heartwood in timber products. Yet standing overmature trees are rated as the most defective of all associated conifers. The amount of cull has been found to increase with tree age and to vary between stands (12, 13). Average cull percents, based on gross volume, were 4 to 6 percent for immature dominants, 21 percent for mature dominants, and 68 to 77 percent for overmature dominants.

The most important single destructive fungus affecting mature incense-cedar is the pocket dry-rot fungus (*Polyporus amarus*), which causes practically all of the decay in this species (3, 14). In parts of the Sierra Nevada, 75 to 100 percent of the mature trees have dry-rot (14). The ports

of entry were fire scars, 84 percent; knots, 10 percent; and injuries caused by lightning and frost, 6 percent (3).

In the management of the second-growth incense-cedar, the age at which dry-rot causes the greatest losses is important. Suppressed trees are subject to severe dry-rot infection after they reach the age of 165 years; dominant trees are generally safe to an age of 210 years (3). Since the rotation age for second-growth stands will probably be considerably less than these critical ages, dry-rot should not cause severe cull in future managed stands.

Two other diseases of incense-cedar are common but usually not fatal. One is incense-cedar leaf rust (*Gymnosporangium libocedri*), which kills small sprays of foliage and causes witches'-brooms and swellings on the branches. Extensive leaf rust infections retard growth and may kill the trees. The second is incense-cedar mistletoe (*Phoradendron libocedri*), which commonly causes spindle-shaped swellings on the branches and occasionally on the trunk (21). The mistletoe occurs throughout the range of incense-cedar. Severe infections suppress growth, but there is no evidence that it kills large trees.

Many kinds of insects are found on incense-cedar, but relatively few cause serious losses. The more damaging ones are the cedar flatheaded borer (*Chrysobothris nixa*), common in the coast region; the western cedar bark beetle (*Phloeosinus punctatus*), which is not generally serious but occasionally kills apparently healthy trees; the western cedar borer (*Trachykele blondeli*) and the flatheaded borer (*T. opulenta*), which mine in the sapwood and heartwood of living trees and are very destructive to timber where sound wood is required; and the amethyst cedar borer (*Semanotus amethystinus*), which usually attacks injured or dying trees but which may occasionally kill apparently healthy trees.

Young trees are readily killed by fire. The thick bark of mature trees offers protection from fire, but intense fires indirectly cause a great deal of damage by exposing trunks to infection by the pocket dry-rot fungus.

RACES AND HYBRIDS

Local races are not identified, but the incense-cedars of southern California have conspicuously narrower crowns and are more spirelike in silhouette than those of the Sierra Nevada. A few horticultural varieties are recognized.

There are no known hybrids of incense-cedar.

Revised from "Silvical Characteristics of Incense-Cedar," by G. H. Schubert. U.S. Forest Serv. Calif. [Pacific Southwest] Forest and Range Expt. Sta. Tech. Paper 18, 14 pp. 1957.

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